ANIMAL HUSBANDRY DIVISION
HAWAII AGRICULTURAL EXPERIMENT STATION
HONOLULU, HAWAII

Under the joint supervision of the

UNIVERSITY OF HAWAII
and the
UNITED STATES DEPARTMENT OF AGRICULTURE

Progress Notes on Experiments and Other Items of Interest

No. 12 December, 1935

These progress notes on experimental work and other items of interest to livestock men in the Territory are issued from time to time by the Animal Husbandry Division. You are invited to suggest other lines of research that you deem important and to submit inquiries to the University.

Dr. Maurice C. Hall, Chief Zoologist of the U.S. Department of Agriculture and Assistant Chief of the Bureau of Animal Industry was invited to come to the Territory to make a survey of the liver fluke problem in Hawaii preliminary to the research and control work which will be carried on by two other scientists from his department who will be in Hawaii for a year or more engaged in this work. Dr. Joseph E. Alicata who will be in charge of the laboratory work in this investigation has already arrived. Dr. Swanson who will do the field work is expected early in December.

This is one of the projects which is being financed by the sugar processing tax under the Agricultural Adjustment Act.

We are pleased to present Dr. Hall's report as No. 12 of our Animal Husbandry Progress Notes.

L. A. Henke.

THE LIVER FLUKE PROBLEM IN HAWAII

by

Dr. Maurice C. Hall, Chief Zoologist
U. S. Department of Agriculture

General Background of Hawaiian Conditions

On a preliminary inspection covering one month, I find that the liver fluke situation in the Territory of Hawaii is apparently of this general order:

Topography:

The fact that all of the islands involved in the fluke problem are mountainous and relatively small, results in certain characteristic features as follows:

There is an absence of what would be termed on the continent large rivers. All streams are relatively very short and usually very small compared with those of any country having long rivers associated with extensive water sheds. The longest river, the Wailuku on Hawaii, is perhaps 15 or 20 miles long and is in a rocky gorge, not a valley, and apparently has no set-up favorable to the snails which carry flukes.

The mountains are very steep and usually relatively limited in extent. Even the extensive slopes of Maunaloa have valleys that are conditioned by extensive lava flows of relatively recent origin, and there are no such valley conditions on any large scale such as would be found on the mainland where the mountain ranges are older and more extensively weathered.

The valleys present a certain amount of swamp land, but the ridges separating them are dry or have very localized wet areas which can be easily drained.

In summary, the problem is very limited in its distribution and its extent in space. By comparison with the continental set-up, the problem is simple in its character and in its solutions.

Soil:

The mountain areas include large areas of lava with flows which may go to the ocean. Below the lava are outcrops of red clay soil, originating in decomposed lava or volcanic ash, some stratified rock of various sorts, a little lime stone and, near the ocean, sand and coral formations. The set-ups for mud of the sort preferred by lymnaeids are of very limited extent as a rule. The islands are relatively new geographically and suitable mud occurs mostly in such areas as can form in the valleys and along the coastal plane. The factors of rainfall and topography often impose limitations on the formation of ranges and swamps.

Rainfall:

There is a striking variation of rainfall between places which are quite close together in many cases. The variation includes extremes of rainfall ranging from hundreds of inches to less than 10 inches. The lesser rainfall is often too slight to support an amphibious snail population, especially in lava country. To a great extent rainfall goes down in porous rocks, into extensive plant root systems and into porous soil. Much of the wet area has such a high rainfall, up to 500 or 600 inches, that the rain has a scouring effect unfavorable to amphibious snails which do not take kindly to swift waters.

Temperature:

While it is definitely colder on the mountain tops than in the valleys or along the coast, the year-round temperatures anywhere in the cattle area are not unfavorable and are probably close to optimum temperatures over most of the area.

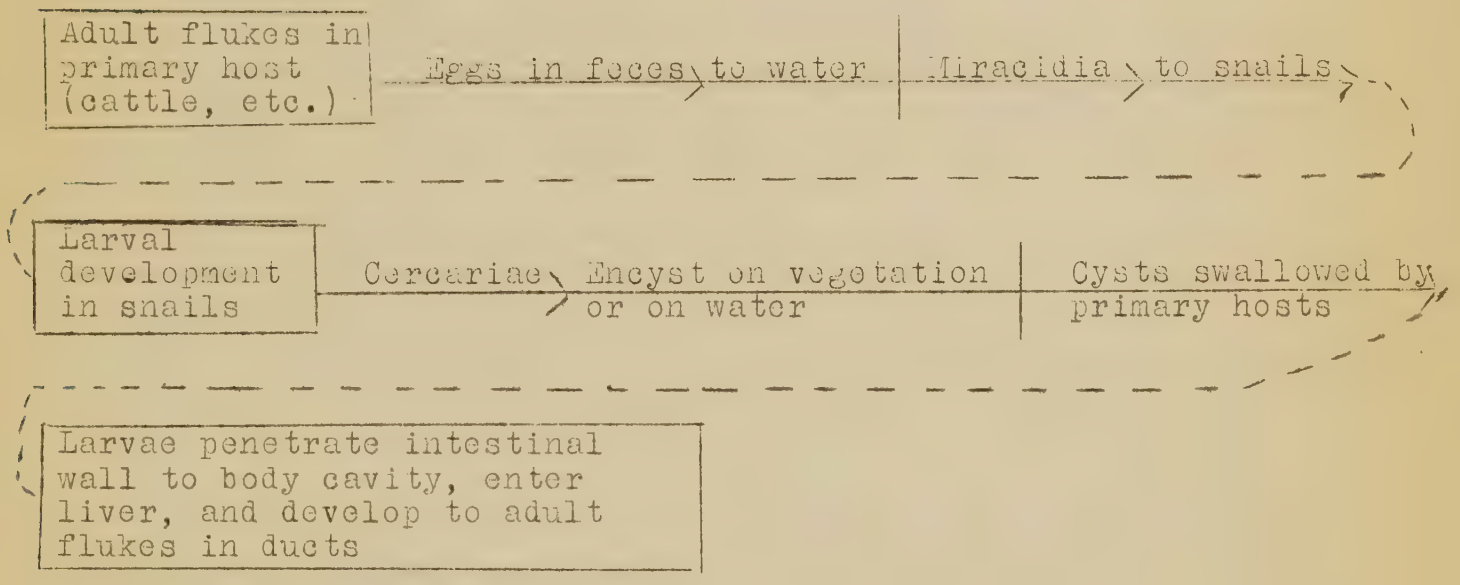
Farm Practice:

The bulk of the cattle and almost all of the sheep are owned by large owners. Beef cattle and many dairy cattle are ranged on grass. Among the important grass are Panicum barbinode; red top; elephant grass; etc. Incidental food includes haole koa, some mimosa, some prickly pear in dry seasons and similar things which appear at this time to be negligent as factors favorable to fluke propagation, and their use is usually of a sort favoring fluke eradication. Some dairy cattle are held in dry yards and fed cut grass, shredded cane tops, cut cane tops and haole koa in addition to other feeds. Pigs are held in both large and small holdings and are mostly garbage fed. There are some wild pigs and goats and sheep and a few deer.

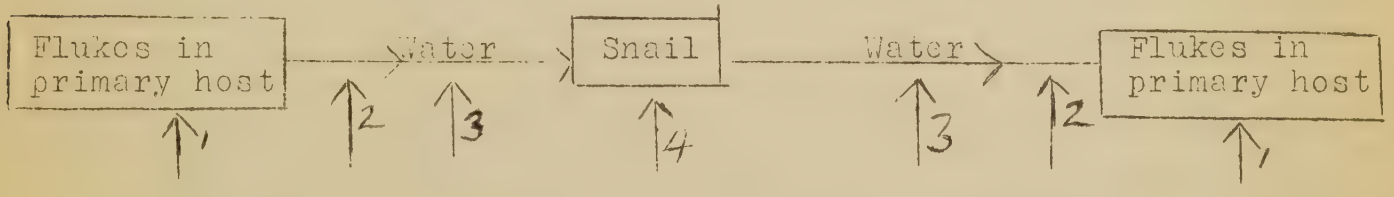
The Nature Of The Liver Fluke Control Problem

In general the problem of liver fluke control can be presented simply and briefly as follows:

The life history of the liver fluke is as given in the diagram below.



The above diagram may be resolved into what are its basic elements, so far as fluke control is concerned, as follows:



The points of attack on the fluke and on its lines of transport are indicated by 7 arrows but, as indicated by the numbering of the arrows, the modes of attack are of only 4 orders, since, for example, a procedure to divorce the primary host from water is equivalent to and identical with a procedure to divorce water from the primary host. Taking up a consideration of the numbered arrows:

1. The attack on the fluke in the primary host is by means of

drugs, of which the best appears to be carbon tetrachloride. For the destruction of adult liver flukes in sheep the dose is 1 cc., and in cattle is 5 cc. Increasing the dose results in increased destruction of flukes in that some or all of the young flukes in the liver are destroyed. For this purpose 5- to 10- cc. doses have been used for sheep. Ordinarily the doses for destroying adult flukes are 100 per cent effective, but no drug is always 100 per cent effective and carbon tetrachloride will leave an occasional fluke or several flukes in some animals.

Within the limits imposed by various factors, treatment may be used, but owing to certain danger factors, treatment should be administered only by qualified veterinarians and then used cautiously. There is no form of attack on liver flukes which is so inexpensive as treatment with carbon tetrachloride, and none which destroys so many flukes, considering the destruction accomplished by stopping egg production at its source. The therapeutic value of treatment in saving the lives of sheep always warrants the use of the drug on sheep and, in all probability, the therapeutic value in saving sheep and young cattle from loss of condition warrants its use on these animals when the indications of damage are present. A remarkable fact, not satisfactorily explained at this time, is that sheep which are dying from acute liver fluke infestation, with numerous young flukes burrowing into the liver from the abdominal cavity, can be cured in the most striking manner by doses of 1 cc. of carbon tetrachloride, in spite of the fact that in this dose the drug does not appear to kill young flukes. Possibly the production of necrosis of liver cells by carbon tetrachloride results in some secondary

phenomenon of some sort--a fibrosis checking the fluke movement, or an immunological response of some sort, or some other topical effect. We have only surmise on this point, and the subject is one for men in the field of research to elucidate, but the observations of those of my associates in the Zoological Division who are engaged in liver fluke work in the field and of my veterinary colleagues in Hawaii are all in agreement as to the value of the treatment.

The treatment of sheep for liver flukes has at this time only one indicated limitation. Throughout the world occasional flocks in rare instances show a fairly high mortality after treatment. Dr. Robert Jay has explained this as associated with an allergic response to abrupt changes of feed shortly before treatment. Food allergics are becoming familiar things and, as Dr. Jay has noted, competent stockmen have known for many years that it is dangerous to switch animals abruptly from one feed to some very different feed. While the deaths of sheep following treatment with carbon tetrachloride require, and doubtless will receive, much more study, it is definitely advisable not to change feeds on animals within a couple of months before treatment, and always advisable to make changes gradually.

The case for treatment of cattle with carbon tetrachloride is more complicated. Quite certainly, milking animals should not be treated. They are highly intolerant of the drug and likely to die from it. Young animals and steers are usually tolerant of the drug, but since clinical injury is seen as a rule in calves and 2-year-old animals only there is little reason for treatment of older animals, and these older animals seldom show large numbers of flukes and often show only the "pipey" livers with heavily fibrosed or calcified bile

ducts indicating previous infestations.

On the whole, treatment is a highly important measure, combining the saving of life, the cure of disease, the prevention of loss, and the destruction of flukes, with a high prophylactic value in that it checks flukes at the source by stopping egg production and to that extent eliminating or greatly limiting the business of rounding up and destroying the larval stages in water, in snails, and on grasses. The fluke in the liver is a target located and within range of our guns; the larvae on the fields are definitely more difficult to locate and to destroy. As regards costs, treatment is a matter of cents when control by field measures is a matter of dollars. Control by all practical measures should be undertaken, since all practical measures are necessary, and it is obviously unsound to ignore a cheap and effective measure solely because we must use in addition more expensive measures, just as it would be unsound not to use artillery just because we must use infantry.

2. The business of divorcing cattle from water, or water from cattle, can be carried out in various ways. Obviously it may be accomplished by feeding cattle, as some dairy cattle are fed, in dry yards, using for this purpose grass cut on safe areas or shredded cane tops, cut cane tops, or haole koa. It may be accomplished by keeping cattle on well drained hillside pastures. We get to the real problem when we find cattle in wet, sometimes swampy, valley pastures, or in pastures through which a stream runs in muddy channels, or in pastures on which there is a localized collection of water, or several such, in the form of springs, pools, ponds, etc.

Unquestionably, the best solution in many cases, and the permanent

solution, for this problem is drainage. While this is the answer, it is not an answer of an entirely simple sort. Drainage must be carried out along the lines of sound engineering. In some parts of the world it has been found that unsound drainage procedures have lowered the groundwater level disastrously. Deep open drainage channels have an element of danger for animals that may fall into them. Open ditches in general have their edges broken down by livestock and afford harbor for snails especially after the banks are broken down. Under tropical conditions ditches often require much work to keep them clean of vegetation. Some of the questions as to location and size of ditches are definitely problems in the field of the engineer, and should be answered by the engineer. The problem of keeping cattle from snail-infested and, hence, probably fluke-infested ditches can be solved by fencing off these ditches. While this is somewhat expensive, it can be done, and has been done in the region northeast of the Pali in Oahu, by the use of relatively cheap fences utilizing 4 strands of wire and a cheap form of fence post. Live guava trees may be used as posts. Near the Pali the use of drainage on some, but not all, wet pastures, confined with the fencing off of ditches and natural water courses, has definitely cut the incidence of liver fluke in cattle during the 3 years that such measures have been instituted and extended.

A measure that seems to have had little attention in connection with drainage as a control for liver fluke is the use of subsoil drainage. The use of agricultural tile for subsoil drainage in suitable soils and areas would answer the problem of fluke control in no uncertain manner, since it would dry a pasture and leave no open water

for snails. However, the cost of tile in Hawaii is considerable, and perhaps prohibitive. In some parts of the world subsoil drainage may be effected by the use of cheap logs, 2 logs being laid at the bottom of a ditch, with a third log on top to form a small subterranean channel. Whether there are in the Hawaiian Islands areas in which this is feasible is uncertain. The use of large rocks to form channel through which small streams may flow, out of reach of livestock, is a possibility worth considering as something that might be practiced in some areas. Most of these problems are problems for the engineer but are conditioned by considerations of cost. In suitable soils a mule may be used to cut drainage channels. If these things are not practical, fencing off of water courses and ditches is often practical

3. Snail destruction can be accomplished in various ways. Drainage which lowers the water table as much as 2 or 3 inches below a pasture will make the pasture safe and leave only the problem of snail control in the drainage channels. Where the channels are narrow and deep, snails at the bottom would present no problem at that point, but should be considered as possibly dangerous in connection with areas into which they drain.

Snails in pot holes, cow tracks and other very localized small areas can be destroyed by broadcasting powdered copper sulphate in sand or some similar carrier. In streams with much vegetation, copper sulphate is rapidly fixed and is of little value for snail destruction In many places in Hawaii any streams which do not have vegetation usually flow through lava and these streams usually do not harbor the lymnaeid snails that carry fluke; they do harbor melania in many cases, but these snails are not yet known to be dangerous. Some evidence

indicates that melania should be investigated as a possible carrier. The common land snails are not dangerous. The lymnaeid situation is slightly complicated by the fact that these snails, which elsewhere are right-handed snails, are both right and left-handed, often in the same species, in Hawaii, according to Dr. Cooke and the observations of Mr. Riley and myself. However, left-handed lymnaeid are exceptional in my own observations and I believe that a restudy of the Hawaiian group would show few valid species of lymnaeid and a great preponderance of the conventional right-handed type.

Observations around Hilo on Hawaii suggest very strongly that the liver fluke in that region is decreasing, and a two-day search for lymnaeids did not bring any to light. There is a possibility that this was due to seasonal conditions or that we missed highly localized areas. However, snails are eaten by frogs, toads, and birds. Frogs are common; Bufo marinus has been introduced and is widely distributed, and may be playing a role. Birds are increasing in some areas. Some of these things may be playing a part in decreasing snails. The introduction of new grasses may have converted some mud swales into grass lands unfavorable to snails. Information at Wailuku on Maui is to the effect that the incidence of flukes at the abattoir has decreased very definitely of late years, pointing to a diminishing problem in the areas supplying cattle to Wailuku.

4. The problem of avoiding encysted cercariae on grass and in water is a problem in safe food and water supplies. Such grass as honohono, cut in wet swamps and streams may harbor cercariae, but is safe if cut on areas outside of swamps and streams, and the same is true for other grasses. Obviously, all of the grasses, cut anywhere,

are safe if no cattle pasture on them, and there is no drainage onto them from areas occupied by cattle. Feed cut on the upstream area above cattle or manure-contaminated areas is safe, but is not safe below such areas. Such feeds as cane tops, fresh or shredded, or haole koa, are safe by virtue of being cut at a level above the range of cercariae infestation as well as by virtue of the dry areas on which haole koa commonly grows. Cercariae usually encyst near the water level, but since water levels change, grass cut in swamps should be cut above any water level and above any point to which growth might have carried cercariae.

Water in raised troughs is not contaminated by manure in the trough, and if brought from safe areas is safe. Overflows should be piped away and not allowed to form wet areas for snails. A float control is desirable. Water in lava channels, free from snails, is safe water, provided the snail-cattle combination does not exist farther upstream.

Variations in Problems

Each ranch, farm or dairy presents its own special problems and calls for the special combination of measures suitable for its needs. In addition to the factors of topography, soil, rainfall, temperature, and farm practice, there is an economic factor of great importance. Not only must the loss from liver fluke be balanced against the cost of control, but the desirability of conserving water in swamps for irrigating cane, or keeping wet valleys as a water supply for range cattle must be considered. However, these are not considerations for the parasitologist. They are considerations for the owners and

managers of the enterprises involved, and are matters of finance not to be solved on a basis of scientific knowledge. Obviously, if snail-infested swamps are left as sources of water for cane, and fluke cattle are kept in the swamps, the benefits from cane must outweigh those from fluke-free cattle. However the ultimate substitution of reservoirs for swamps, not only to escape fluke and the mosquitoes that carry dog heart worms but as a more practical method of conserving water must be regarded as inevitable.

Sample ranges of conditions on the various islands are as follows:

Oahu

1. The worst problems lie on Oahu in the region north of the Nuuanu Pali. Here are extensive and deep swamps, with an abundance of lymnaeids and with fluky dairy and beef cattle. The problems can be solved by drainage in the upper part of the valleys, and call for engineering advice as to proper procedure. In the lower region towards the ocean the water is used for irrigating cane. Apparently the pumping station now there could lower the water table below the ground level, but there is a question as to whether the division of excess water to the ocean at one season might create a shortage of water at other times. Taking a long-range view, one may say that it is hardly conceivable that good dairy and beef cattle will be run on swamps in any high grade livestock industry for any long period in the future and we may surmise that in due time a suitable reservoir, and good pasture will replace the swamp. However, this is a matter of economics and engineering which will probably receive consideration in due time.

In the dairies south of the Pali and toward the east end of Oahu,

the fluke problem is one of limited extent or difficulty. In some cases care in cutting feed from safe areas is all that is necessary. In other cases, fluky cattle could be segregated on the lower reaches of streams, near the ocean. In the dry region south of the Waianae Mountains the indications are that snail-infested areas, if present at all, would have a highly localized and limited extent, and that control would be simple. The high rocky area and the coastal sand areas are both unfavorable for lymnaeids, and favorable areas, if present at all, must be very few. The rocky streams are unsuitable for lymnaeids. North of the Koolau Mountains, much the same appears to be true, and care in feeding and avoidance of limited wet areas or the drainage of such areas appears simple and feasible.

Kauai

As regards Kauai, the situation is as follows:

On the western end of the island there is a large extent of upland mesa land which would be safe for cattle if it were not for the fact that cattle use the steep canyons between the mesas for water and for the honohono grass. A safe elevated water supply could be provided at the heads of these canyons, and the streams fenced off for a couple of years until fluke infestation in cattle had died off, since flukes ordinarily die in 9 months, although some live a year or longer. The consideration here involves the cost of fencing and loss of honohono grass for 2 years, as compared with benefits from fluke eradication.

Near Waimea the fluke problem is of limited extent. One stream has a crossing that can be fenced off, and the irrigation ditches,

mostly carrying a melania population in sandy soil and lava, carry lymnaeids in pond scum, and these ditches can be fenced off.

Near Waimea the present method of feeding cut haole koa appears to afford adequate protection from fluke, and the snails in the swift-flowing ditches are apparently all Melania.

The large swamps in the region northwest of Mt. Waialeale are probably of little importance in the fluke problem. A few head of wild cattle on this area with its hundreds of inches of rain annually may produce a certain number of cercariae, but in that vast area almost all of the cercariae will encyst in the abundant vegetation, and probably too few would ever succeed in making the trip to the lower areas inhabited by cattle to have any significance.

In its general pattern, the central portion of the island may be ignored as fluke area. A festoon of mesas forms a safe area. The valleys between the mesas and the low country between the mesas and the ocean present fluke problems of limited extent and capable of control if control is desired.

Hawaii

On Hawaii the known fluke areas appear to be limited to the region around Hilo and to the canyon at Niulii. The canyons east of Niulii should be investigated as possibly infested. A two-day search around Hilo disclosed no snails other than melania, and this raises the question as to whether melania is a carrier, something which has probably never been investigated but should be, or whether the lymnaeids are highly localized or perhaps seasonal in occurrence. There is a possibility that a former fluke problem is decreasing.

Niulii was not visited. Most of the region between Hilo and Niulii is too rugged and the streams too steep and rapid for lymnaeids.

The Puna, Kau, Kona, and South Kohala districts present areas which have no history of fluke, no lymnaeids, and no set-ups favorable for lymnaeids. Some areas are much too dry for fluke country, some too steep. The low areas that might otherwise be swamps are in grass, but devoid of mud and free from snails so far as could be detected by sampling.

Maui

On Maui the fluke area apparently lies on the north side of the island for the most part. South of Haleakala the extensive lava beds are too recent for weathering to have established favorable conditions for snails or flukes. Along the coastal region north of Haleakala there are areas favorable for snails, and lymnaeids were found in the Keanae region. These snail areas are of limited extent, and control by drainage would be simple.

There is a special problem in the form of some ponds between Kahului and Paia. Cattle from the areas around have been fluky in a high percentage of cases in the past, and for a year, as a result of advice from the Deputy Territorial Veterinarian, Dr. Fitzgerald, only horses have been pastured on these areas. A very large collection of snails from these ponds showed nothing but melania in hundreds of specimens. This particular case indicates that melania needs investigation as a possible carrier. We cannot assume that our rules in parasitology will always work, and they must be used only as guides

to probable things. Under the special conditions in Hawaii, melania may have taken on the role of a carrier of Fasciola. In some of its sites, in swift-flowing streams, it would have little importance as a carrier, since miracidia would rarely succeed in attacking it, but in its optional sites in ponds and sandy irrigation ditches, it might be important if it is a carrier.

The evidence from the abattoir at Kahului is to the effect that the former high incidence of fluke there has fallen to a very low figure of late years. This may be attributed in part to cooperation in fluke control on the part of owners and managers with Dr. Fitzgerald Possibly incidental changes in the flora and fauna and in farm practice have a bearing on the situation. Over the islands one finds constant improvement in grasses as regards suitability and density of stand, and apparently they have taken over many swamp areas and converted them into pasture.

Molokai

According to reports, there is fluke on Molokai. The island was not visited, but judged from an airplane, much of the land could not support a snail population and any fluke problem is probably much localized.

Niihau

According to one of its owners, this island is very dry, there are no flukes, and no possibility of fluke transmission.

Kahoolawe

This island is too dry to support flukes, according to report

and airplane observation.

Lanai

Lanai is said to have no fluke problem, probably.

Medical Aspect of Fluke Problem

From the casual investigation possible in the limits of a one-month tour of the islands, eight cases of sheep and cattle liver fluke in man came to light. In one case at Hilo, a boy 10 years old was found to have Fasciola hepatica in the gall bladder. An examination of the fluke by me showed that it was unusually large, 43 mm. long. I was told that the boy had a subsequent operation for gall bladder trouble and another fluke was found. This was Dr. Burlingame's patient. Dr. Sextion at Hilo told me he had found the fluke in operations, during 25 years in the abdominal cavity in four cases. One man who is associated with one of the large companies told me that his wife had had an operation about 14 years ago for liver fluke. This case was on Oahu and was charged to water cress carrying the fluke. Two other clinical cases on Oahu were reported to me. Undoubtedly there must have been many such cases in the history of the islands, but they have not been assembled in the literature.

Over some areas in all four islands water cress must be regarded as dangerous unless grown in water which cannot be contaminated by cattle or sheep manure either nearby or at a remote point in a stream. The encysted cercariae are like pearls of pin-point size, easily recognized under laboratory conditions but too difficult to detest under market conditions to make an examination useful in avoiding

danger. Cress of uncertain origin should never be used unless cooked at temperatures equivalent to the boiling point for several minutes. The fact that the fluke will parasitize man is a reason for its eradication. It may cause very severe symptoms in man and may menace the life of the patient.

SUMMARY OF LIVER FLUKE SITUATION

There is nowhere in the Hawaiian Islands a liver fluke problem comparable in extent and difficulty to the problems in the continental United States. The problem reaches its maximum intensity in the region north of the Nuuanu Pali and here it can be solved, as a scientific problem, by the drainage engineer. The real difficulty here lies in a conflict between drainage and water conservation for irrigation, which is an economic problem to be solved by the owners and managers, not by the parasitologist. On a long view one must believe that at sometime in the future the water will be impounded in a suitable reservoir, and the pure-bred cattle now running in swamps will be run on safe and well drained pastures.

In most other places fluke control seems to be attainable by simple and not too expensive measures. At some places a little drainage, at others the cutting of straight channels with sharp sides to do away with meanders and back waters, at others the cutting of safe feed for dairy cattle and the avoidance of grass cut on swamps on which there are cattle or into which cattle manure can drain, at others drainage with fencing off of ditches, at others fencing off of limited danger areas until all cattle are free from flukes and the fluke infestation on the swamps has died off or been destroyed by

burning, at others the use of some copper sulphate on limited wet spots. The extent to which drugs should be used should be left to competent veterinarians.

In connection with grass cut on swamps, Dr. Willers has suggested that the machine used for drying grass by heat might be of value in killing cercariae. This is an interesting suggestion that should be given attention. The machine is used in large dairies in the continental United States for reasons quite aside from fluke control, and might be of sufficient value for these reasons and for its value in salvaging dangerous swamp grass to warrant its cost. The matter deserves consideration.

Much of the area on the various islands is quite safe from fluke. In some areas there is a history of a decreasing fluke infestation. To explain this decrease we have various possibilities. Changes in farm practice and in flora and fauna are possibilities. As a result of sound veterinary advice, and of recommendations from the University of Hawaii, some owners and managers have carried out measures to control flukes, and in the aggregate these measures have greatly diminished the incidence of flukes. Improved pasture grasses have probably converted many mud spots into grass-covered areas unsuitable for lymnaeids. Moreover, such grasses tend to keep cattle on the safer areas, whereas poor grasses in competition with honohono grass in dangerous areas are not good enough to attract the cattle. The familiar practices of plowing and disking tend to level out contours and thus fill up swamps. The introduction of Bufo marinus and of birds that eat snails has probably resulted in a definite decrease in the snail population.

In spite of definite improvement of the fluke situation in some places, flukes should be eradicated. The limitations of the problem make it easy now, and an island is a specially favorable set-up for control. At present cattle are mostly under the control of large concerns, and these concerns commonly control their water supply to its source. Few owners make the problem simpler since there are few persons to contact or convince.

There is no assurance that the indicated decrease in flukes will continue and will not reverse for the worse. The history of most countries indicates a tendency for a large range cattle industry to break down into many small-scale holdings under farm conditions, and the problem of concerted action by many persons is a difficult problem. Over almost all the islands there is a zone between the mountain tops and the ocean where temperature and moisture conditions are almost perfect for year-round snail and fluke development. At present the soil condition afforded by relatively recent lava is unfavorable, but age and the action of new plants will change this.

At this time control should be carried out, and such measures taken as will prevent the return of the fluke to the islands or its transfer from island to island. This could probably be accomplished by concerted agreement on the part of cattlemen and dairymen under veterinary advice and without resort to regulatory action. There would be definite benefits to the cattle, the pastures and the cattlemen and dairymen, and to the public health in protection from human fascioliasis.

The present program calls for at least one year's work on liver fluke by a laboratory scientist at Honolulu, who will make some field studies, and a field veterinarian who will visit the islands and

suggest specific control measures for individual range and dairy outfits. For both these men I bespeak the friendly cooperation that I have received from all persons with whom I have come in contact.